The Influence of Soil Organic Matter Stabilization Mechanisms on Carbon Mean Residence Time Within Various Ecosystems in the United States

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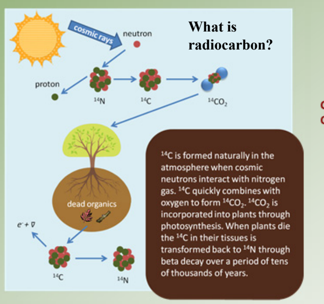
Abstract

Some terrestrial ecosystems and soils serve as carbon sinks, partially offsetting rising atmospheric CO_2 levels. Physiochemical mechanisms of soil organic matter (SOM) stabilization affect how carbon stocks respond to global warming. In order to clarify the variance in SOM stabilization mechanisms across different soil types, SOM abundance, distribution and mean residence time (MRT) were compared for thirty-two soil samples from six ecosystems across the United States. Soils were previously described, collected and archived by the United States Geological Survey. Samples were processed by LLNL at the Center for Accelerator Mass Spectrometry (CAMS) using density fractionation to separate particulate organics from mineral components. SOM abundance and distribution were compared among sites. Graphitization and radiocarbon analysis conducted at CAMS determined $^{14}C/^{13}C$ ratios which were used to evaluate differences in SOM MRT across the various ecosystems. Results confirmed SOM turnover varied among sites; therefore the response of SOM to global warming may vary among soils. Data from this investigation will be used in quantitative ranking of soil stabilization mechanisms and management of this important carbon sink. Initial investigation will allow for quantitative ranking of soil stabilization mechanisms and management of this important carbon sink. Further work will explore how variance in SOM MRT is related to particular soil physiochemical properties such as mineral assemblage.



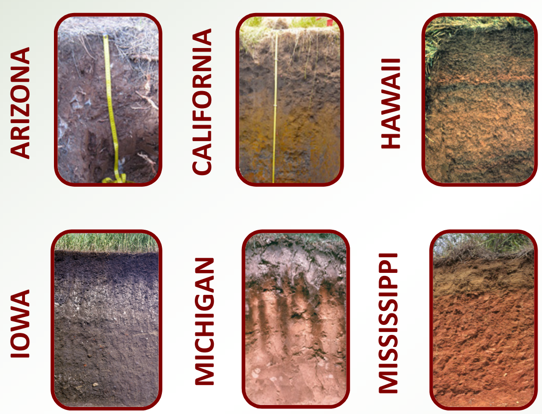
Soil sampling ecosystem locations: Arizona, California, Hawaii, Iowa, Michigan and Mississippi.

Objectives

•**Context**: The global pool of soil organic carbon is large and therefore changes in its flux rate can have a significant impact on atmospheric CO_2 values. However, the mechanisms regulating the stabilization of soil organic carbon are not well understood.

•Objective 1: Examine different soil types and soil organic matter stabilization mechanisms and observe how they vary among ecosystems.

•Objective 2: Observe the variance in distribution and mean residence time of carbon in six different soils types and ecosystems.



Soil types and locations: Arizona-Mollisol, California-Alfisol, Hawaii- Andisol, Iowa- Mollisol, Michigan-Spodosol, and Mississippi-Ultisol

Methods

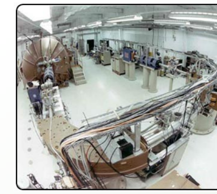
•Soils are density separated using a Na polytungstate solution.

• Free-light, occluded and high-density soil fractions samples are converted from organic carbon to carbon dioxide then to graphite.

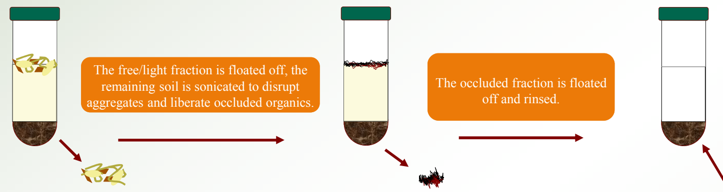
•The graphite is sent through the accelerator mass spectrometer to calculate the $^{14}C/^{13}C$ isotopic ratios.

•Radiocarbon values are used to model the mean residence time of C in each fraction.

Graphite reduction line



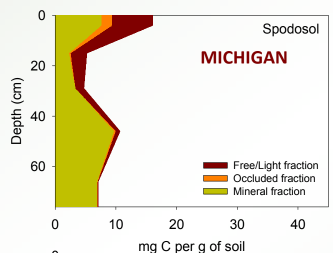
Accelerator Mass Spectrometer at CAMS-LLNL.

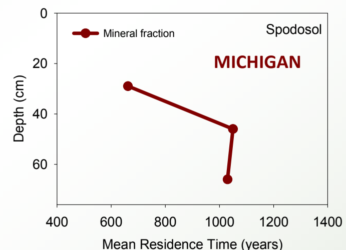


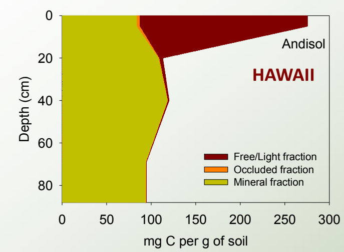
Free/Light fraction is composed of particulate organics at different stages of decomposition.

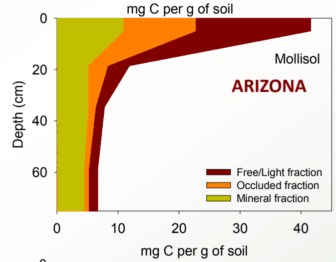
Occluded fraction is composed of particulate organics which have been preserved through occlusion within aggregates.

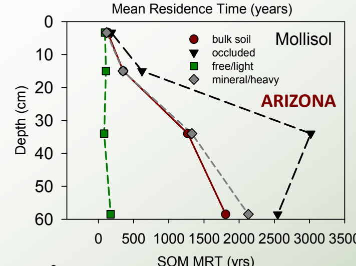
The remaining soil is composed of minerals and organics bound to mineral surfaces through a variety of mechanisms.

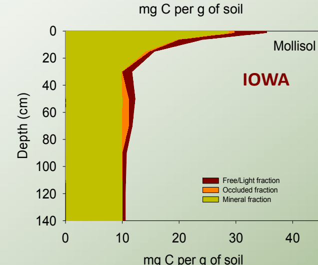


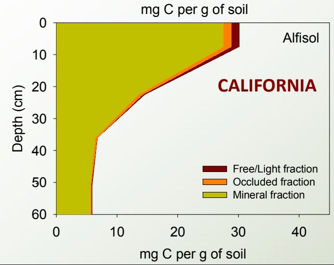


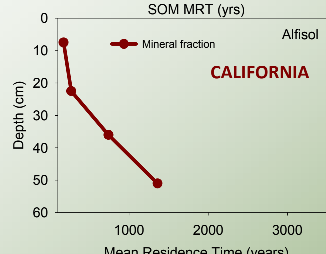


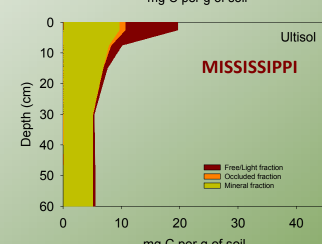












Results

•Soil organic matter abundance and distribution a density/aggregate fractions varied significantly ac to soil/ecosystem type.

•Soil organic matter mean residence time varied a soil/ecosystem.

•Soil organic matter mean residence time also var among soil density/aggregate fractions for soils examined.

•Differences in soil organic matter abundance and residence time are likely linked to differences in c and also specific mineral assemblages of the soils examined.

Discussion

•Previous research indicated that soil organic C v abundance and mean residence time across ecosy type, and these variances are the product of environmental and edaphic properties (Jenny, 194 Quantifying the relative influence of climatic and properties on soil organic matter stability is cruci predicting the response of soil C stocks to changi climatic conditions (Lal et al., 1997).

•The current work involves preliminary character of soil organic C cycling in a variety of ecosysten the first step in a broader effort to quantify the inf of the mineral matrix on the stabilization of organ The results illustrate a broad variance of soil C ab and mean residence time in these ecosystems.

•Patterns of soil C distribution and stability are a reflection of the differences in the vegetation, clir and soil mineral assemblage at each site.

•Future work will characterize the unique minera assemblage at each location. Following character of the mineral component, statistical analysis will to identify key stabilization mechanisms in each s Results will be used to model the response of soil C stocks to changes in climate.

References

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Lal R, J M Kimble, R F Follett and B A Stewart (eds), 1997. Soil and the Carbon Cycle. CRC Press, Inc, Boca Raton, FL.

Acknowledgement This research was conducted at Lawrence Livermore National Laboratory and supported by the U.S. Department of Energy, Office of Science. The STAR Program is administered by California Polytechnic University, Center for Excellence in Science and Mathematics Education (CESaME), on behalf of the California State University. This project could not have been accomplished without access to the wet lab at The Center for Accelerator and Mass Spectrometry and for all the help Paula Zermeno offered. I thank the Office of Educational Programs and the Science Teacher Program for hosting our research and for all of their hard work creating, organizing, and funding this experience. My sincere gratitude goes to my mentor, Kate Heckman PhD., for providing a posi research experience, and for her guidance. This material is based upon work supported by the S.D. Bechtel, Jr. Foundation, National Marine Sanctuary Foundation, Carnegie Corporation of New York, and National Science Foundation under Grant Nos. 0952013 and 0833353. The opinions, findings, conclusions and recommendations expressed herein are those of the authors and do not necessarily reflect funders point of view. This work is performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA 27344.

LLNL-POST-64